Helping Farmers in Zimbabwe Use Seasonal Climate Forecasts:
Six Constraints to Effectiveness

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Introduction

A better understanding of El Niño teleconnections has allowed scientists to issue seasonal climate forecasts for places around the world. There have been many groups of intended users for this information: water planners, food security agencies, public health officials, and farmers. Farmers can potentially mitigate the consequences of drought (Phillips et al. 1998, 2000; Scoones et al. 1996). They can plant different seed varieties, plant earlier, plant fewer seeds per hectare, and withhold fertilizer. When rains are light, each of these can result in a greater yield, or a similar yield at reduced cost, But if the rains are moderate to heavy, these steps will result in yields that are lower than they otherwise would have been. As with all farming decisions, the decision-making calculus hinges on a variety of economic, social, and geographic factors, in addition to the expectation about above or below normal rainfall (Katz and Murphy, 1997).

But the evidence is scarce and mixed as to whether farmers actually have used the forecasts (Glantz, 2001). A common example is Brazil in 1991, where the forecasts appear to have allowed farmers to make better decisions, and substantially cut their losses from drought. But in subsequent years, Brazilian farmers were less enthusiastic about using the forecasts, and perceived the forecast as being wrong. Moreover, the success in Brazil in 1991 involved actually giving farmers the appropriate seed to plant; there is no evidence that without this "bribe" they would have chosen to plant different varieties. Broad and Agrawala (2001) show how, in Ethiopia, there are many good reasons why seasonal climate forecasts may not be useful to farmers. In southern Africa, government and NGO organizations tried during the 1997 El Niño to help farmers make use of the forecast (Unganai, 1998), but the results appear mixed at best (Patt, 2000). Applying the forecasts at the level of the individual farmer offers both the greatest challenges and the greatest rewards. This user group has little experience making use of external scientific and technical knowledge, and faces a diverse set of decisions that vary geographically and from year to year. But if these farmers can use the forecasts to make better decisions, not only their vulnerability to El Niño but also their dependence on national and international aid will be less.

In this paper we focus on Zimbabwe to develop a model of forecast effectiveness. The ENSO signal is relatively strong in southern Africa because of its effects on the Intertropical Convergence Zone, and relatively important because of the region's dependence on rain-fed agriculture (NOAA, 1999). A study by Cane et al. (1994) showed that not only rainfall, but more importantly yields of maize—the country's primary food staple—correlated significantly with El Niño. In response to a close call with famine during the 1991-92 El Niño, policy-makers across the region, and in Zimbabwe in particular, have put in place pathways of communication between scientists and national- and regional-level decision-makers (Stack, 1998). In the next section, we examine the factors limiting forecast effectiveness. After that, we present preliminary results from an ongoing experiment designed not only to make the forecasts more useful, but also to test whether they actually can be useful in practice to subsistence farmers.

Six Constraints to Forecast Effectiveness

There have been numerous studies of the determinants of assessment and forecast effectiveness. For example, Orlove and Tosteson (1999) posit that the most important factor is that there be "fit" between the forecast message and the information needs of the user. Cash (2000) develops the concept of the "distributed information and decision support system." He suggests that those organizations bridging the gap between scientific research and real-world decision-makers—boundary organizations (Guston 1999)—work best when spread out into the networks of users, helping them to understand the information and supporting their ability to make decisions based on it. Perhaps the most comprehensive set of studies of assessment effectiveness, compiled by the Global Environmental Assessment research group at Harvard University, developed and made use of a model that examined three proximate causes of assessment effectiveness. While many factors may actually lead to more or less effectiveness, three proximate variables are a useful starting point for predicting whether an assessment, or forecast, will actual be effective in influencing decision-makers: credibility, legitimacy, salience (Farrell et al., forthcoming). Credibility refers to the degree to which actors believe the information as true, and hence are willing to rely on it. It is a function not only of the message, but also of the messenger. Legitimacy refers to the degree to which actors think that the information is fair, taking their opinions and perspectives into account, and hence is something on which they would feel morally comfortable basing decisions. It is a function of the processes that users perceive as generating the information. Salience refers to the degree to which actors know about, and care about, the information in the assessment, whether the information is relevant to their lives. It is a function of the information content, and of the decisions that actors face.

We use this latter model to analyze forecast effectiveness among farmers. While we analyze credibility and legitimacy directly, we build on the model by distinguishing four separate factors that can increase or reduce a forecast's salience. Hence, we discuss six sets of constraints. First is the *scale* constraint: it may not contain information that is locally specific, and tailored to their decisions. Second is the *credibility* constraint: they may not trust it, especially if past forecasts appear to have been wrong. Third is the *cognitive* constraint: they may not understand it, especially if it uses difficult concepts such as probability and chance. Fourth is the *legitimacy* constraint: they may not respect it if it comes to them from outsiders, based on outside knowledge that they don't know about, and does not incorporate their own local experience. Fifth is the *institutional* constraint: they may not have had a chance to adapt their normal way of doing things to allow the use of new and infrequently delivered information. Sixth is the *choice* constraint: the information may not provide enough new knowledge to induce a rational and risk averse decision-maker to change any preexisting choices.

The first five constraints arise from a failure to consider the needs of the audience, and hence from not analyzing and communicating the information well enough. Hence there ought to be ways of overcoming these five, should one choose to put in the time and effort. The last constraint, if it exists, is more problematic. It is a function of the limits of scientific predictive capacity and the complicated array of choices available to and incentives faced by decision-makers on the ground. In this study we ask the question of whether the forecasts could ever be useful, and hence whether the sixth constraint—the one least amenable to rapid change—applies.

In order to examine this constraint, however, one must make it binding, by eliminating the others. This task in and of itself may be difficult. The literature suggests ways of overcoming the other constraints, but these have not been well tested in the context of rural communities in developing countries. Hence, the effort to learn about the sixth constraint can offer important lessons about whether the other five can be overcome, and if so how.

Scale

The *scale* constraint arises when information covers a wide geographical area, such as en entire continent, region, or country, but where the local ramifications of that information remain unclear. In the case of southern Africa, SARCOF forecasts provide information for the entire SADC region. After the SARCOF forecast, each country then "downscales" the forecast to its own country. In Zimbabwe, this downscaling has usually added little additional content; in 1997, for example, the downscaled forecast was simply a map of Zimbabwe alone that provided the same predictions as the SARCOF forecast had. These predictions are probabilities of above normal, near normal, and below normal rainfall. In a year with no additional forecast information, the probabilities to be expected are 33%, 33%, and 33% for each event. The 1997 forecast, by contrast, predicted a 15% chance of above normal rain, a 35% chance of near normal rain, and a 50% chance of below normal rain, for almost all of Zimbabwe. In 2001, the forecast called for a 35% chance of above normal rain, a 45% chance of near normal rain, and a 20% chance of below normal rain.

But these predictions of probabilistic deviations from climatology cross a diverse landscape, where the distributions of seasonal rainfall differ significantly, and this can generate confusion. In Zimbabwe, agronomists classify the country into five "natural regions", with lower numbered regions offering much better growing conditions due to heavier rainfall. The two largest cities in Zimbabwe—Harare and Bulawayo—share the same climate forecast in most years, including 1997 and 2001. But as Figure 1 shows, Harare lies in natural region II and usually receives close to 1000 mm of rainfall between September and May, whereas Bulawayo, closer to the Kalahari Desert, lies in natural region IV and usually receives about 600 mm of rainfall between October and April. It is a mistake to interpret the seasonal forecast, being the same for both cities, to mean that both cities will experience similar weather, but many are tempted to do so. A farmer living near Bulawayo might rejoice at the forecast, thinking that rainfall similar to that usually experienced in Harare is likely, and that it would be appropriate to plant the longer season maize varieties appropriate for natural region II. This would be a mistake.

[Figure 1 about here]

A more accurately downscaled forecast will predict the probabilities of different amounts of actual rainfall for each city, examining the historical record for each. Three factors stand in the way. First, in mountainous parts of Zimbabwe, rainfall patterns are very heterogeneous over a small physical area. Second, official measurement in many rural areas of the country is spotty at best. Third, many farmers may not quantify rainfall in terms of millimeters of rain over a season. Combined, these three factors mean that it may not be possible to downscale forecasts based solely on official records, and even if it were possible, the result may not mean much to the users. This highlights the necessity of communicating with farmers for their own experiences, as opposed to relying solely on official data. Such a communication process would discuss the probabilistic forecast, and compare its predictions for rain with other years in farmers' memory. Certainly some years stand out as below normal years—1982-83, 1991-92, 1994-95—while others stand out for having above normal rainfall, most recently 1999-2000. The forecasting process would seek farmer's opinions about recent years' rainfall in their particular area, and express the likelihood that the coming year would be like some of these years in recent memory.

Credibility

The *credibility* constraint arises both from the failure of past years' forecasts to be accurate, and from the failure of the forecast communicator to have built a reputation of trust. The first problem will necessarily occur when forecasts are communicated as being deterministic, rather than probabilistic. Many people have suggested that citizens are incapable of understanding a probabilistic forecast, and hence it may be better to disseminate one that is deterministic, telling exactly what will happen (Glantz et al., 1997; Nicholls, 1999). The anthropological literature supports the idea that farmers may not find probabilistic forecasts easy to understand. Bourdillon (1993), for example, describes the traditional rural belief system as not incorporating the idea of chance or luck; rather, some action, such as failing to respect one's ancestors, brings about bad events. In Zimbabwe, the National Early Warning Unit within Agritex decided specifically to avoid discussing forecasts probabilistically, and so has communicated the forecasts to farmers deterministically. The media goes the same course for different reasons: it is more newsworthy to report a forecast of certain drought than one of likely drought. A content analysis of newspaper coverage in Zimbabwe of the 1997 El Niño revealed that while the first stories to appear on the subject did discuss it in uncertain terms, as the issue grew to prominence more and more stories were likely to discuss impending drought as a certainty (Patt, 2000). Then, after the drought did not occur as "predicted", the climatologists—who themselves had never predicted certain drought—were blamed for faulty predictions. Other evidence, from Brazil, highlights a similar phenomenon. Forecasts were deterministic, and the first year that events did not unfold exactly as predicted, people stopped trusting them (Orlove and Tosteson, 1999). Others suggest that forecasts should be communicated in their full probabilistic version—the raw forecast—precisely so that users can understand their limitations, and learn to trust them for what they are (O'Brien et al., 2000). Finally, research has shown that rural forecast users can base decisions on probabilistic information, about as well as educated westerners (Patt, 2001). Not trusting the mental capacity of users is likely a poor reason to issue a deterministic forecast, and the practice is likely to backfire.

The second cause of low credibility comes from the reputation of the messenger. Reputations of trust are difficult to build and easy to destroy (Slovic, 1993, Freudenburg, 1996); if users perceive the forecast communicator having been wrong in the past, and that communicator does not have a strong existing track record of being right, then it is unlikely she will be trusted. Cash and Moser (2000), examine how communication pathways—from global knowledge to local action—can build or destroy relationships of trust. Citing evidence from the social studies of science literature (e.g. Alcamo, Kreileman, and Leemans, 1996; Jasanoff, 1990; Guston 1998), they suggest that some pathways are better than others because of institutional factors. For example, the institution broadly described as *science* contains mechanisms, such as peer review, for enhancing the trust among its members. Thus, we might expect a local scientist working at a land-grant university to trust the peer reviewed literature on global environmental change, even though the two scientists will never meet face-to-face. But absent such institutional mechanisms for enhancing credibility, trust is best developed and maintained through face-to-face contact and repeated interaction.

In Zimbabwe, farmers currently receive the official forecast through the media, and from their local extension officer. As Phillips et al. (2000) note, many farmers hear the forecast on the radio, and in El Niño years the newspapers carry a great number of stories (Patt, 2000). While the media may be the most effective way of informing a large number of people, it is unlikely to increase the trustworthiness of the forecasts. This is especially so in a country such as Zimbabwe, where the media are primarily state-run, and perceived as serving the interests of the governing political party. Agritex extension officers may do somewhat better, although their contact is extremely limited. An informal survey of farmers across Zimbabwe revealed that few had met with their extension officer in the past year, and many had never met him at all (Patt, 2000). While extension officers are able to discuss the forecasts directly with farmers, they do not have a track record of trust off of which to draw.

Compare to this the pathways by which farmers learn of the traditional forecasts. Village elders, the people that farmers trust the most, make predictions about the coming season by observing a number of natural indicators, such as the direction of winds, the friskiness of animals, and the migration of birds (Scoones et al., 1997; Phillips et al. 2000; Phillips 2001; Ziervogel 2001; UNSO 2000). Local religious leaders often take the opportunity, in their sermons, to communicate these forecasts (Shumba, 1999). Perhaps efforts to communicate forecasts to farmers would be more successful if they invited the cooperation of local leaders whom farmers trusted and respected. These would include village elders and religious leaders, as well as people working at local health clinics and schools.

Cognition

As noted above, many actors choose to communicate deterministic forecasts because they are worried that farmers can not understand the probabilistic versions. If users do not understand a forecast, it is not likely that they will use it, and if they do use, they may use it wrongly. Simplifying the forecast is an attempt to circumvent the *cognitive* constraint. An alternative strategy is to overcome the constraint through capacity building, teaching users what the information means, and how to interpret its complexity. Unlike circumvention of the cognitive constraint through simplification, efforts to help users understand the fully complex forecast also work to enhance credibility, legitimacy, and can be an important avenue for overcoming the scale constraint.

[Table 1 about here]

The literature in risk communication has increasingly turned to participatory approaches as improving user understanding. Fischhoff (1995, 1996) summarizes this in Table 1. Leiss (1996) and Renn (1998) tell essentially the same story, although they describe but three phases. The first phase lasted until the mid-1980s, and was centrally concerned with the accurate quantification of risk. Risk managers assumed that people would use this quantitative information to make consistent choices about which risks to accept gladly, and which to shun (Leiss, 1996). But a number of studies (e.g., United States Environmental Protection Agency, 1987; Zeckhauser and Viscusi, 1990; Breyer, 1993) showed a sharp divergence between popular opinions of risk and the opinions of so-called experts. The assumption was wrong. In risk communication’s second phase, the focus was on advertising good risks as good, and bad risks as bad (Leiss, 1996). Empirical research in behavioral economics had, by then, shown that people responded to risk and uncertainty at an emotional level (Tversky and Kahneman, 1973; Kahneman and Tversky, 1979; Covello, 1990; Kammen, Shlyakhter, and Wilson, 1994). Risk managers and communicators tried to harness what they understood about people’s interpretation of risk to get them to do the right thing, using rhetorical techniques already developed within advertising, sales, and marketing (Leiss, 1996).

These efforts to circumvent people’s lack of understanding, first by telling them what to do and then by trying to convince them to do it, ultimately backfired because they exacerbated the problems of credibility and legitimacy. Instead, the practice of working with citizens, in highly participative local processes, took hold. Leiss' third stage of risk communication "is characterized by an emphasis on social context, that is, on the social interrelations between the players in the game of risk management" (Leiss, 1996, p. 90). Risk communicators learned that only when information users became experts in their own right, and were treated as such, would credibility and legitimacy not suffer. As O'Brien et al. (2000) note: "It is important that the end-users receive the 'raw' climate forecasts and not only the interpretations of the forecasts (i.e. advice or suggestions) so that they maintain control over their own decisions."

In the case of Zimbabwean farmers, however, many doubted that they possessed the basic analytic tools in order to participate at all (Patt, 2000). In response, Patt (2001) conducted experimental research in Zimbabwean villages using methodologies borrowed from psychology and behavioral economics. He offered subjects the opportunity to win money be placing bets on a simplified roulette wheel. Subjects chose from a choice of two possible bets; in each case, one bet offered a higher average payoff, and in some cases less risk. Patt analyzed the choices of each individual over a series of thirty bets, in which the payoffs and probabilities varied, to determine whether they understood the probabilistic character of the experiment, made consistent choices that maximized their expected earnings, and learned to make better choices as the experiment progressed. Patt rejected the hypothesis that these farmers could not learn to understand probabilistic information. His findings were consistent with similar experiments conducted by others in the United States and Europe. In rural Zimbabwe, as elsewhere, people find probabilistic information difficult to understand, but with practice do better and better. Forecasters should neither ignore nor circumvent the cognitive constraint; rather, they should overcome it through participatory education.

Legitimacy

The *legitimacy* constraint arises when users question the political agenda of the communicators. Even something as innocuous as seasonal climate forecasting is not immune. Broad (1999) shows how, in Peru, large corporations benefited from the forecast, while individual farmers and fishermen suffered when market conditions changed. In Zimbabwe, lending agencies restricted credit to farmers when the 1997 forecast predicted drought (Patt, 2000). To the extent that forecasters recommend taking particular actions in response, their motives can come into question. As Farrell et al. (forthcoming) state, "legitimacy is at issue when an assessment is perceived as recommending behavioral changes by one group of actors that would disproportionately benefit some other group of actors." People who mistrust the motives of the forecasters are not likely to listen to what they are saying.

Nothing opens the mind like knowledge. Weber (1997) shows how the existing sources of news influence how receptive farmers can be to new information. She found that farmers who believed in climate change as a long-term global phenomenon—legitimating the advice of scientists—were significantly more likely to have perceived local short-term climate fluctuations, and to have changed their farming practices in response to those perceptions. She then went on to examine why a particular farmer would or would not believe in global warming. Such a belief, she found, was not correlated with demographic variables such as age, experience, or level of education. It was correlated, however, with farmers' source of information. Farmers who received their information from more sources, and for whom agricultural newspapers was one of those sources, were more likely to believe in global warming than farmers who relied on fewer media sources, sources generally limited to the popular media (e.g. daily newspapers, television, radio).

It is possible that farmers would not want to believe the official scientific forecast, because they do not understand the scientific methods used to develop it, and because they could see using it as conflicting with the practice of relying on local indicators. It is important, then, for farmers to understand not only the information content of the forecast, but also the data on which scientists reached their conclusions. Communicators should present the official forecast not as superceding the local one, but as complimenting it.

Institutions

The *institutional* constraint arises when people's or organizations' standard operating procedures stand in the way of using the new information. Orlove and Tosteson (1999) described the idea of *institutional fit*; users and forecasters needed time to adapt to the presence of the new information. Often it is possible to adapt the information to fit within the ways people do things, in order to make the information useful. In other cases, people can change how they go about making decisions, in order to allow the use of an expanded set of information.

In Zimbabwe, institutional practices have often constrained forecast use. For example, the Southern African Regional Climate Outlook Forum, where meteorologists from across the region meet to agree on a single consensus forecast, occurs in late September. The week after that, the Zimbabwe Department of Meteorological Services holds its "downscaling" meeting, attended by representatives from Agritex. In the weeks to follow, Agritex holds meetings to discuss the forecast, passing it down through the organization to the regional and then district offices. The forecast eventually reaches the Agritex extension officers in late November or December. But farmers generally purchase their seeds in September, and plant in October and November, so the information arrives too late to be of use altering the choice of varieties. If Agritex were to provide the farmers with the information earlier—such as the first week of October—and farmers were to wait until they had received the information prior to purchasing their seed, then there would be a better institutional fit.

Both participation and repetition are essential ingredients to effective forecast communication that overcomes the institutional constraint. Two things happen iteratively. First, forecasters learn how farmers go about making their decisions. For example, many farmers in Zimbabwe do not purchase their own seeds. Instead, their children, who hold jobs in the city and actually have money to spend, purchase the seeds, delivering them to their parents when they visit prior to planting. It might be useful not only to broadcast the forecast to urban audiences, taking into account their different knowledge base. Second, the users would figure out ways to change their practices so as best to accommodate the new information. Building on the same example, many farmers might tell their children to wait until hearing about the forecast, before deciding what seeds to purchase.

Choices

Finally there is the *choice* constraint to the use of information: does the forecast contain enough new information to alter any real decision. In theory, this is a simple question to answer. In practice, it is nearly impossible to predict.

First the theory. Katz and Murphy (1997) describe the static cost-loss ratio, a typical way of modeling forecast usefulness. In the simplest case there are two possible outcomes for the growing season, which they will connote with the variable Θ: drought ($\Theta = 1$) and no drought ($\Theta = 0$). A farmer can plant a high yield crop, which will do poorly if there is a drought, incurring a loss L, such as losing the entire crop. Alternatively, the farmer can protect against drought by planting a low yield crop that is insensitive to the amount of rainfall. But the protection incurs a cost of C, such as a lower yield than the farmer is used to with the normal variety. If the farmer's objective is to minimize the expected expense, then the decision of whether to protect depends on the probability of drought, p_Θ, and the relative magnitudes of C and L; the farmer should protect if $p_\Theta > C/L$, and not protect if $p_\Theta < C/L$. Only when the forecast changes p_Θ enough to push it past the C/L threshold will it be useful.

In reality, this logic is complicated by at least three factors. First, the choices that farmers face are not binary. Most farmers in Zimbabwe plant several different varieties each year; even a small piece of information could influence them to alter the ratio of long season and drought tolerant varieties. Second, the climate forecast does not actually offer the probability of crop failure, but rather of seasonal rainfall totals. The success of a crop can depend as much on the timing of the rains as on the total amount that falls. In 2001, for example, much of Zimbabwe experienced a drought for the entire month of January. Beginning in mid-February, the season turned very wet, but it was too late to save the crops that had already wilted. It is a matter of judgment, by each farmer knowing the history of her fields, to incorporate the seasonal climate forecast into the calculus of crop failure. Third, and potentially most important, farmers—like most people—are neither risk neutral nor unboundedly rational. Most can not afford to risk losing their entire crop, and so plant safer varieties on many of their fields, so as to increase the chances of harvesting enough food for survival, rather than maximizing expected yields. Indeed Phillips et al. (2000) suggest that forecasts may be most useful when they predict a low probability of drought, rather than a high probability. In these years, farmers will be willing to take the risk of planting seed varieties with higher expected yields, and investing in additional inputs such as fertilizer. Predicting degrees of risk aversion is tricky. Kahneman and Tversky (1979) show that it can depend as much on shifting perceptions of the status quo as on objective factors such as wealth or access to alternative means of survival. Finally, most people do not solve the maximization problem for anything, but instead choose the first available option that is good enough, a decision-making practice commonly known as bounded rationality. Since farmers are not planting the optimum portfolio of seed varieties anyway, a forecast informing them that the optimum is now different will have little impact. Only if their current practices become unacceptable, rather than simply sub-optimal, will farmers choose to change what they do.

The choice constraint is, then, both dreadfully important and impossible to predict through theory. Hundreds of social scientists, including me, spend thousand of hours every year trying to make climate forecasts more useful to farmers and other users, primarily by overcoming the other five constraints. But if the choice constraint is binding, then these efforts are futile. Only when the state of forecasting science improves to the point where it can provide more definitive information, will the choice constraint change. In the meantime, the money could be better spent on other programs.

Learning about the limits of the choice constraint requires not theory but observation. If one observes real farmers, with their own background knowledge and willingness to take on risk, using the forecast to make different decisions, then one can say that the choice constraint does not bind. But what if one does not observe farmers using the forecasts, as indeed appears now to be the case in Zimbabwe and elsewhere? Only if one is confident that the other constraints are no longer a factor can one then conclude that it is the choice constraint that limits the usefulness of the forecasts. To determine whether the choice constraint binds requires one first to eliminate the alternatives. The remainder of this paper describes an ongoing project to do just this.

Experimental Project: Testing Choices

The theoretical discussion makes clear that an effective forecast communication process must include several features if it is to avoid the first five constraints to forecast use. It must downscale the information to the local, not national, level. To enhance credibility it should provide farmers with the full probabilistic information, and involve members of the community whom farmers trust. Given that probabilistic forecasts are difficult to decipher, it should include efforts to help farmers understand the complicated information, preferably giving them an opportunity to ask questions. To maintain legitimacy, it should inform farmers of the data on which the scientific forecast is based, and should include discussion of the local traditional indicators and they might also be useful guides for action. To allow for the institutional matching of information and decisions, it should occur regularly—not just in bad years—and include two-way communications so that the forecast communicators can learn what information the farmers can use.

Such a communication process would be very expensive to implement. Furthermore, such a communication process would not in and of itself guarantee that the forecast turn out to be useful; even if the first five constraints disappear, the choice constraint could still stand in the way of farmers using the forecast. Before policy makers institute such a process, they should have some indication that it would work. But as described above, without such a process, there is little chance of predicting whether a forecast could be more effective.

Given the expense involved, and the uncertain payoff, it is no surprise that current forecast communication practices, in Zimbabwe and elsewhere, fail to match up with the theoretical-based requirements. In Zimbabwe, there is a limited communication of the deterministic forecast from Agritex extension officers to farmers, taking place in years when unusual growing conditions are likely. There is also the broadcast of the forecast over the radio. While these efforts are worthwhile, they will probably not provide enough information to policy makers to justify a greater investment in more effective forecast communication.

A solution to this problem is to implement the more effective forecast communication practices not nationwide, but in a small number of experimental locations. The farmers participating in such an experiment would not be hurt in any way—they would, after all, be receiving more accurate and complete information than their fellow countrymen—but they would have an opportunity to vote with their feet. If, given the best opportunity to use the forecast, they chose to do so, then that would indicate that the forecast could be useful nationwide. If they chose not to use the forecast in their decision-making, then that would suggest that the forecast may bot be useful, and that the investment in a better communication process, nationwide, would not pay off. This experiment at forecast communication is, of course, what we have begun.

Methodology

Beginning in October 2000, and continuing in September and October 2001, we have conducted local “climate forecast workshops” in four communities in Zimbabwe. Figure 1 shows the locations. Two of them are near Chimanimani, at the edge of the Eastern Highlands in high rainfall zones: Tiya is in natural region II; Mahkwe, only 20 km distant, is in natural region III. The other two are in western Zimbabwe, in drier areas: Mafa is near Lupane, in the heart of natural region IV; Matopos is south of Bulawayo, at the edge of natural regions IV and V. The four communities provide a cross-section of Zimbabwean farming practices, and so can offer valuable information about the likely success or failure of efforts to communicate the forecasts.

The workshops took place as soon as possible after the annual SARCOF forecasting meetings. The reason for this was to give farmers the forecast as early as possible, at a time when they were purchasing their seeds and considering how much of which varieties to plant. Figure 2 shows the SARCOF probabilistic forecast for early and late seasons in the two years. Neither 2000 nor 2001 was an El Niño year in which drought was predicted, but by starting the process of regular forecast communication, both farmers and communicators will have learned from each other for at least two years prior to an El Niño occurring, a prerequisite to overcoming the institutional constraint.

[Figure 2 about here]

Each workshop lasted between three and five hours, if one includes follow up conversations with farmers. Three of the four sets of workshops took place in the local primary school, with the headmaster and several teachers participating; the Matopos workshops took place at a commercial center, with the chief, but no teachers, participating. In the week prior to each workshop, the local Agritex extension officer and the schoolteachers spread the news about the workshops, and invited a random sample of people to attend. The Matopos workshops had about fifteen participants each year, while the other workshops had between forty and seventy participants. The Agritex extension officer attended the workshops, and led the discussion at the end about recommended seed varieties and financing options, but did not serve as primary facilitator. One of the authors, Anthony Patt, was lead facilitator at all of the workshops. Chiedza Gwata, the other author, was secondary facilitator and translator at the workshops near Chimanimani. At the Mafa workshops, the secondary facilitator and translator was Joseph Ngwenya, a teacher in the primary school. At the Matopos workshops, the secondary facilitator and translator was Alan Eason, a businessman now living in Bulawayo who had grown up in the village.

Men and women attended the same workshops, although in all cases they chose to sit on different sides of the room. Often in participatory rural assessment (PRA), women and men meet at different times, giving women an opportunity to speak their minds without fear of being judged by the men in their community. We did not follow this practice but did, however, encourage women to participate by asking many of the questions directly to their side of the room. In the first year of the project, we found that women did participate, almost as much as men. In the second year we continued this practice of holding a single workshop, for both men and women.

Each workshop included discussion of the following questions:

- Local Climate. What were farmers' impressions of the past year's rainfall and growing conditions? How did it compare with other years in recent memory, including drought years such as 1991-92? What are the normal patterns of rainfall throughout the season? The purpose for this component of the workshop was to obtain the information necessary to overcome the scale constraint.

- Local Indicators. What indicators, if any, foretell the rains for the coming season? What had the indicators said last year, and did they seem to be correct? Were there any years in recent memory when the indicators had successfully predicted an unusual amount of rain, either very wet or very dry? Were there any years when the indicators had failed to predict an unusual amount of rain, or had predicted unusual rains but then were wrong? What are the indicators saying for this year? The primary purpose for this component of the workshop was to help to overcome the legitimacy constraint.

- Local Crops. What varieties of seeds do farmers usually plant in this area? When do they plant them? What types of yields do these crops provide on different types of fields, under a variety of rainfall conditions? What did they plant last year, and how did those crops do? Why do farmers choose these particular varieties, compared with others? Had farmers ever decided to plant different varieties, based on the information learned from their local indicators? The primary purpose of this component was to overcome the scale and institutional constraints. The secondary purpose of this was to obtain information necessary to analyze the choice constraint.

- El Niño. Many farmers have heard of El Niño, via the media or from their Agritex extension officer. We conduct a short (20 minutes) information on El Niño, and how it often causes different weather effects around the world. We include in the discussion the fact that El Niño prediction is still new, and scientists are learning all the time. We conclude this part by discussing the impacts that El Niño and La Niño usually have in Zimbabwe, and how it is possible to make predictions for Zimbabwe based on sea surface temperatures. The purpose of this component was to overcome the credibility and legitimacy constraints.

- Probabilistic Climate Forecasting. We discuss the form of probabilistic forecast that is issued at SARCOF and generally adopted by the Zimbabwe Department of Meteorological Services. First, we explain the concept of uncertainty and probability, using visual aids such as spinning a roulette wheel, or pulling numbers out of a hat. In 2000, we played a gambling game similar to that reported in Patt (2001), paying out cash prizes the size of which correlated to the skill at interpreting probabilities. We then discussed the meaning of the different probabilities contained in the climate forecasts, and how that might translate into local effects. In 2001, we also asked farmers whether they remembered the previous year's forecast. Did they think it had been generally right, or was it misleading? What kind of information would the forecast have to provide if they were to change actual decisions, such as what varieties to plant? The purpose of this component was to overcome the cognitive constraint.

- The Current Forecast. We present the current forecast, as issued the week before at the SARCOF meeting and downscaled for Zimbabwe. How does this forecast compare with the forecasts for the last few years? What are the important pieces of information in this forecast? How does the forecast compare with the information provided by the local indicators? We presented this information, in this detail, at this time, in order to build on the information already presented, and overcome all six constraints.

- Decisions for this Year. Together with the Agritex extension officer, we then discussed the possible response strategies for the current year, given the climate forecast and local indicators. Did farmers find it useful to know this year's forecast? Did they intend to change any decisions based on the forecast? What particular seed varieties, and other planting options, were appropriate for the current year, given this additional information? How do these choices compare with those made last year, given the two years' forecasts? This component of the workshop, both the plans for this year and the comparison with what was done last year, provides the primary data for determining the importance of the choice constraint.

After the formal part of the workshop, we break for lunch. In the two workshops near Chimanimani, this consists of a full hot meal, prepared by local women, with soft drinks and beer. In the two western workshops, the meal was simpler—sandwiches—but the soft drinks and beer remained the same. In all locations, the facilitators would meet with the local leaders over lunch, and find out from them their opinions on how the workshop had played out. In 2001 in the Chimanimani workshops, the lead facilitator also returned for an hour the next morning, to answer any questions people might have had. Furthermore, in all of the sites except Matopos, the lead facilitator returned to the village later in the first year (January for Mafa, May for Tiya and Mhakwe). He used this opportunity to say hello to the schoolteachers who had been present at the workshops, and to inquire about people's recollections of the workshops and experiences during the growing season. The purpose of these visits was to maintain some contact with the villages, mainly so that they would be assured that the workshops would occur again the following year. By knowing that the workshop would come, they would be more likely to adapt their standard procedures—such as when to purchase seed—to make use of the forecasting information; hence this would help to overcome the institutional constraint.

Observations

Neither 2000 nor 2001 carried a strong ENSO signal; the forecasts for Zimbabwe carried a high probability of normal to above normal rains, as Figure 2 shows. One can not, therefore, draw firm conclusions about the usefulness of forecasts in an El Niño year when the probability of drought is high. However, there are valuable lessons to be learned from the first two years of this project. On the one hand, a carefully crafted participatory approach to forecasting appears able to overcome the first five constraints. By the second year of the project, participants in all of the workshops were enthusiastic about the information, and were eager to put it to use. On the other hand, in these non-El Niño years, there simply was not very much, in a practical sense, that they could do with the information. We discuss the observations leading to these conclusions, below.

Year One—Chimanimani Area Workshops

Thirty-five people attended the October 2000 Mahkwe workshop. They discussed the rains that they usually received, saying that they received much less than the highlands immediately to the east. They did not provide any specific amounts of rain that they usually received. Rains usually began in early- to mid-October, with the heaviest being in January and February.

They observed a variety of local indicators. These included several fruits, such as those on the Mazhanje tree; a lot of fruit on the branches would predict good rains. When the winds blew from the Save River, to the west, they could predict that rains were coming. When it became very hot early in the spring, they predicted heavier rains eventually to come. Finally they observed the clarity of the air—when, prior to the rainy season, the horizon was especially fuzzy due to low air clarity, that meant that good rains would come. A similar indicator was the presence of a halo around the moon. Almost everybody agree that the indicators this year were almost uniformly good, and that the season would be good.

Farmers in Mhakwe said that they generally planted maize as their primary crop. They used hybrid seed almost exclusively, favoring the varieties SC401, SC501, and SC513 produced by the Zimbabwean Seed Company, Ltd. Of these, SC401 is the shortest season variety, and also has the lowest yields. They did not give precise yield figures, but indicated that SC501 and SC513 would give substantially greater yields—roughly twice as great—when the rains were sufficient. In most years there was sufficient rainfall to support all three varieties, although in drought years, such as 1991-92, the rains were insufficient. Farmers indicated that they usually planted the same mixture of crops from year to year, although if one crop had done particularly well the year before, they were likely to plant a little more of it the following season. Some farmers indicated that they planted SC513 only on those fields with the best soil quality. Some farmers said that they generally planted equal amounts of each of the three varieties.

The workshop participants were very interested in El Niño. Many of their questions revolved around whether El Niño (or La Niña) had caused Cyclone Eline, which had devestated the region with floods the year before. Other questions were concerned with whether El Niño was becoming stronger over time, since they observed less rainfall now than they did many years ago. To lead off the discussion of probabilistic climate forecasting, we played a probability game in which people won money, and that generated a great deal of enthusiasm. They were somewhat interested in the forecast for 2000-01. The Agritex extension officer suggested that they should weight their planting toward SC501 and SC513, rather than SC401. There was little reaction to this advice.

Twenty-five people attended the Tiya workshop, two days later. They were far less participatory than the farmers in Mahkwe had been, although they did answer questions, when asked. As with Mahkwe, they did not provide specific quantities of rainfall that they received, and they recalled 1991-92 as being an especially bad year. Their local indicators were mostly the same as those in Mahkwe, except that they places more emphasis on air clarity, and did not mention the wind, coming from the west, as a factor. Their principal crop was maize, and they planted primarily SC501 and SC513, with very little SC401. Some farmers, however, also planted some SC709, a longer season variety. They indicated that its yields were substantially greater than those of SC501, although they did not say how much greater they were. They typically planted SC709 only in the low-lying fields that retained moisture, and in years with poor rains the SC709 did poorly.

The Tiya farmers showed less interest in El Niño, and in climate forecasting in general. They asked a few questions about Cyclone Eline, although none about climate change over time. They also were enthusiastic about the probability game. The Agritex extension officer, the same man as for Mahkwe, again indicated that they should plant mainly SC501 and SC513, with some SC709 in the wetter fields. There was little reaction to this advice. Overall, the Tiya farmers were much less enthusiastic than the Mahkwe farmers had been. This was especially true among the women.

Year Two—Chimanimani Area Workshops

The two workshops near Chimanimani took place in the last week of September, 2001, a few days after the release of the SARCOF forecast but before the Zimbabwe downscaling meeting. Both workshops had more people the second year, including nearly all of the people who had attended the year before. People participated more the second year: there was always someone who wanted to say or ask something. This was especially true in Tiya, where the previous year the participants had been quite subdued.

Forty people attended the Mahkwe workshop. Several of the farmers had kept detailed records during the 2000-01 season, and noted that there had been a dry spell lasting twenty-one days during January. Nevertheless, there was good moisture in the soil, and the year had turned out generally well. People agreed that both the natural indicators and the scientific forecast had been accurate in their predictions. They said that the natural indicators—the Mazhanje and Mango trees, the winds, and the very low air clarity—predicted another good season for this year.

People were very upset about the price of seed this year. The economic situation in Zimbabwe had gone from bad to worse in the past year, and the price of seed had risen almost three-fold. A 10kg bag of SC401, SC501, or SC513 seed now cost ZW$1500, and each hectare needed 25kg of seed.[1] Thus, each farmer needed several thousand dollars for seed; many said that they did not have this, and did not know how they would buy seed. An argument ensued over whether the practice of retaining hybrid seed from the previous year's harvest worked. Many people said that they had had good results when they mixed together retained seed and new seed. Others said that it was only the new seed that actually grew and produced maize. The Agritex extension officer advised against using retained hybrid seed, but suggested that if anyone had retained seed that was not a hybrid variety, they should plant that. Only two people did. The Agritex officer also mentioned a loan scheme instituted by the national Grain Marketing Board, but nobody had yet heard of this, and he did not give them more information about it.

People were happy to hear that the forecast for this year was again good, predicting only a small probability of below normal rain. Having seen the forecast from the year before turn out fairly accurately, and now understanding it better having heard the same story of El Niño twice, they said that they trusted the forecast. They were enthusiastic about its usefulness; it was very helpful, they said. However, when pressed for how the forecast was useful, they could not give a firm answer. They did not intend to do anything different from usual in response to the forecast, but to plant the same three varieties as usual, if they could afford the seed. The farmers said that if they knew it was going to be a bad year, they would plant more SC401 than usual, whereas if they knew it would be a good year they would plant more SC513.

Pressing on this point, we proposed some hypothetical forecasts, such as the one from 1997 (50% chance of below normal rain, 35% chance of near normal rain, 15% chance of above normal rain), and asked if these forecasts provided enough certainty to cause the farmers to change their decisions. Everyone agreed that these forecasts did not provide enough certainty, and that they would not change their behavior. We also pressed them on the accuracy of the traditional indicators. The participants agreed that the indicators were good, but not foolproof. In 1991-92, for example, the indicators had predicted a good season, but in fact the season had turned out poorly. In truth, the farmers said, one could gain some confidence about how the season would turn out, but one could never be certain. We asked whether anybody had ever planted different varieties, changing their behavior in response to the natural indicators. Nobody ever had. What then, we asked, made the scientific forecasts useful, as they had said they were? Several farmers responded that the forecast workshops were enjoyable, because they learned about El Niño and the effects it had on farmers and fishermen around the world, and because knowing the forecast helped them to plan for the coming year. Even though there were no farming-related decisions that they would change, it was nice to have a better idea what would happen.

Thirty-seven people attended the Tiya workshop. They had experienced the previous season much as the Mahkwe people had: a dry spell in January, but generally a good season. They agreed that both the natural indicators and the forecast had been on target. They agreed that the natural indicators, in particular the haziness of the air, pointed to another good season ahead,.

During the 2000-01 growing season, nobody had changed any decisions in response to the forecast. The most popular variety planted was SC513, followed by SC709 and SC501. Only four people had planted SC401.As with the participants in Mahkwe, people agreed that this year's forecast was both good, and helpful. They would continue to make their usual decisions.

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[1] At the time, the official exchange rate was ZW$55 to US$1. On the "parallel" currency market, the exchange rate was fluctuating between ZW$200-300 to the US$. Inflation in Zimbabwe was over 100% per year, although wages had risen far less than this.

Again, we pressed them to elaborate on why the forecasts were helpful, when apparently they did not change any decisions. At first, people could identify no specific answer. Ultimately, however, the group did agree on a reason, related to the worsening economy. While SC-513 cost ZW$1500 per 10kg bag, SC-709 was even more expensive, and less convenient. It came only in 25 kg bags, and these cost ZW$5000. Farmers who planted SC709 would have to people to share bags with, and more importantly would have to save extra money. If the forecast had not been good, they reasoned, they would likely plant less SC709 than usual, because of the extra expense. However, given the good forecast and natural indicators, they would cut back their other expenses and try to save money for the SC-709 seed. When asked how they could save this much money, the participants joked: the men said that their households would drink less tea, while the women said that their households would drink less beer.

Year One—Mafa Workshop

Almost fifty people attended the Mafa workshop in October 2000. Located near the edge of Hwange National Park in natural region 4, this site is less well suited to maize. People discussed the crops they grew; most planted maize, although some people planted millet and sorghum as well. People preferred maize to millet and sorghum, because the latter two crops required much more processing after harvesting (pounding), and because birds were more likely to eat them, as were elephants. The most popular maize variety was SC401, although people also planted some another short season variety, Pannar 6363, as well as SC501. People indicated that the yields of SC501 were twice those of SC401 in normal years, while millet and sorghum had yields somewhat less than SC401. In years with below normal rainfall, SC501 did not do well, and often died entirely. Millet, sorghum, and SC401 all produced about similar yields when rainfall was below normal. However, when we asked which years had been "below normal", people agreed that most years were in fact "below normal." In very good years they had "normal" rains, and almost never did they have "above normal" rainfall. People said that the rains were usually below normal because they were in a dry part of Zimbabwe, and also because many years ago it had consistently rained more.

The natural indicators here were different from those in the eastern sites. People mentioned several species of flowering trees, winds from the north, and in particular strong winds that "shifted about", and did not consistently blow in any one direction. People said that during storms there was often this kind of wind, and so when they saw this wind before the season, they knew there would be a lot of rain. Most people agreed that the indicators pointed to a good year ahead. One man disagreed, and said that he did not think that the indicators were good.

People at this workshop participated about as enthusiastically as those people at the first year's Mahkwe workshop had. They were pleased that the official forecast showed a low probability of drought, and hence matched the general interpretation of the natural indicators, and they suggested that sticking with their normal mixture of varieties would be best. Following the workshop, the Agritex officer talked for 15 minutes, during which he suggested that farmers plant a mixture of SC401 and SC501, as usual. For most of the farmers, this was the first time they had met him. He also discussed how they could make rain gauges out of tin cans, and keep records of rainfall to improve their ability to understand the forecast. When we returned to the site later in the season, we found that several of the farmers had started to do just this.

Year Two—Mafa Workshop

Fifty people attended the 2001 Mafa workshop, held on October 1, roughly half of whom had come the previous year. Farmers said that they had also experienced a dry spell in January, but unlike the farmers near Chimanimani, these ones had lost most of their crops to the mid-season drought. The ones who had done well had either planted SC401 very early, so that it matured before the drought became severe, or else very late, so that the plants were smaller and less vulnerable to the drought, and then benefited from the heavy rains in February and March.

Farmers said that the traditional indicators had been wrong the year before, since they had promised good rains and good harvests. They said that the last year they had been so surprised was in 1991-92, when the indicators had also predicted a good season, and there had been a devastating drought. By contrast, many of them actually thought that the forecast had been “dead right.” The forecast had called for a low probability of drought both in the early season (October, November, and December) and in the late season (January, February, and March). The drought, many of them said, had come right in between the two seasons, so neither forecast was really wrong. However, they wanted more information about how to use the forecast—what decisions should they make differently?

We explained that the fact that there were two forecasts did not mean that there were two distinct growing seasons. Many participants agreed that they had misinterpreted the forecast, and that by having the opportunity to discuss it at this year’s workshop, they came to understand it better. Indeed, the participants said that the forecast still had been accurate, since in fact the total amount of rain was about normal, and they understood that the forecast did not say whether the rain would fall evenly throughout the season, or in dry spells and rainy spells. They hoped that in the future the forecast would be able to provide this information. As the Agritex officer said, echoing the sentiments at the workshop:

> Last year we were not trusting the forecast. Farmers did not understand very well what you were talking about. Even I, as an advisor, did not trust the forecast. But now, having seen the events of the last year, we realize that everything happened about as you said it would. Farmers did not have a good season, since they were surprised by the mid-season drought. Now we understand the forecast better, and I think that the farmers are armed with important information. But we are still hoping that the rains will be good.

As at the 2001 Chimanimani workshops, farmers said that the local indicators pointed to another good year. We pressed them on whether they trusted the indicators, since the perception was that the previous year the indicators had been wrong. They said that the indicators usually were correct, but that sometimes there were surprises. We asked them specifically about 1991-92, and there was disagreement. Some people said that the indicators had pointed to a good year that year, while others said that the indicators had pointed to a bad year. Finally, we asked who it was in the village who examined and interpreted the indicators. They responded that only the elders knew how to interpret the indicators—of the fifty people at the workshop, four people said that they knew how to interpret the indicators.

People were glad to learn that the forecast again pointed to another year with only a low probability of drought, and initially said that this information was very helpful. Again, we pressed them to decide in what ways it was helpful. As at Tiya, there was an eventual answer related to the economy. Because of the poor harvest the year before, and because of the high prices for seed, many felt that it would not be possible to plant crops on all of their fields. But with the good forecast, they would try to find the money to purchase the additional seed. Perhaps, some thought, they could sell a goat, or some chickens, to raise the money for seeds. While many of them had in the past sold animals to raise money, the participants were not sure whether it would be possible for all of them to do so at once.

We also asked about planting retained seed. None of them planned to plant any retained hybrid seed, but they did say that many people had some non-hybrid maize seed, and planned to plant that. The retained seed was not as drought tolerant as SC401, but perhaps it would survive anyway, especially if this year were good.

At the close of the workshop, the Agritex extension officer made a presentation in which he discussed ways of raising money for seeds. He talked about the possibilities for selling livestock, and in particular discussed the loan scheme of the Grain Marketing Board. He invited farmers to speak with him personally, after the workshop and in the coming weeks, to learn about how to participate in the loan program.

Matopos Workshops

Only twelve people attended the October 2000 Matopos workshop, including the village chief and the Agritex extension officer. Apparently, a member of the community had died the day before (my interpreter said that he suspected the death was of AIDS), and the local traditional healer was conducting a ceremony to prevent other people from contracting the disease. Most members of the community had decided to attend that ceremony, rather than the climate forecasting workshop. Unlike the other workshops, this one took place not in a school, but in a community meeting room in the main commercial building, which also housed the general merchandise dealer and the bottle store and cocktail bar. The Agritex extension officer acted as facilitator for this workshop.

The farmers at this workshop participated much less than had those at the other three sites, and it was difficult to obtain information. The participants said that the same indicators used in Mafa were also useful there. This year, the indicators pointed to a good season. They said that they planted mostly SC401, along with millet and sorghum, and occasionally some SC501 as well. They did want to discuss yields, however, other than to say that the crops generally did quite poorly. They were not displeased to learn that the official forecast was good for this year. However, several people specifically said that they did not really trust the official forecast; it is impossible to predict how the rains will fall, and all one can do is plant and hope. Moreover, the forecast was not useful to them, as almost all of the people at the workshop had already purchased their seeds, and several had planted their fields already.

In the second year, 2001, the Matopos workshop was similarly uninspiring. The Agritex extension officer did not show up, and indeed had failed to invite people to the workshop. Only the village chief had learned, and he was there waiting to discuss the forecast with us. After an hour of waiting for the Agritex extension officer, we held the workshop with ten participants, sitting in the shade of a tree. Only the chief had attended the workshop the year before, and he was by far the most enthusiastic.

As with the first year, people were not enthusiastic about the forecast, and with the exception of the chief, did not consider them helpful. Two points, however, stand out. First, three of the ten participants had heard the official forecast on the radio the year before. It had predicted heavy rains, beginning late, and they felt that it had been in error. They did not understand how it was developed, and were not intending to trust it this year, or to follow its advice. They said that they appreciated our coming to the village to discuss the forecast, because then they could ask questions. They said that perhaps, if this probabilistic forecast proved to be accurate, and they had an average or above average season, they would consider making use of it the following year.

Second, they were very depressed by the high price of seeds, and many were planning on planting retained seeds. The chief said that the village had some old, non-hybrid seeds, which they intended on planting. Furthermore, another, nearby village also had some non-hybrid seeds. The chief remembered that in earlier times, when people planted non-hybrid retained seeds, the villages in the region had made a practice of swapping seed with each other every second year. He asked us whether we recommended this practice. We replied that we did not know, but suspected that there had probably been good reasons for the practice, if their ancestors had followed it. Perhaps, we suggested, they should try it on a limited basis, and evaluate the results. The chief thought that this was sensible advice, and indeed offered the lead facilitator, Anthony Patt, a plot of land in the village on which to carry out this experiment, along with a hut to live in for the duration. The offer was politely declined.

Discussion

The workshops offer several new insights into forecast usefulness. In their second year attending a workshop, most farmers appeared enthusiastic about trying to incorporate the forecasts into their decision-making, especially in the second year they attended a workshop. Even a small effort to overcome the first five constraints appears to have worked reasonably well. But while this willingness to use the forecasts is there, identifying practical ways of using the information is much more difficult.

Participation

Participation is important, especially if one is to communicate new and complicated information. Repeatedly, workshop participants stressed that because they were able to ask questions, and had those questions answered, they were able to understand the climate forecasts. Even questions completely unrelated to decision-making, such as where the name “El Niño” came from, were important for them to ask, in order to feel more comfortable with the information content of the climate forecast. By contrast, the farmers in Matopos who had heard the forecast on the radio specifically said that they neither understood nor trusted it, both because they could not see the person telling it to them, and because they could not ask questions.

Participation, especially when repeated, can also identify ways in which people misinterpreted the forecast. One gentleman in Mafa said that he had kept his eyes open for yellow flowers, since the poster used to show the climate forecast had a lot of yellow on it. Others there had concluded that the forecast meant there were two distinct growing seasons. Without participation, and active facilitation, these errors of interpretation would likely go overlooked.

Repetition

Repetition turned out to be important for several reasons. First, people understood the complicated information about probabilities better the second time they heard it. This could have been because of the cumulative effects of learning; many people attending the second year’s workshop remembered the exact forecast from the year before, but had some questions about what it really meant. It could have been because of greater familiarity with the workshop process; in every case, people participated more and asked more questions the second year they attended a workshop. Second, repetition enhances the credibility and legitimacy of the information messengers. By coming a second year, we showed that we actually cared about the participants’ longer-term interests. It is not uncommon for outsiders to show up in a village, provide some assistance, and then leave without a trace. Third, a longer-term commitment is especially important if farmers are going to change their own practices to incorporate the new information.

For example, if they are going to delay purchasing seeds until after the workshops, they need to be confident that the workshops will actually occur. Fourth, repetition is necessary to identify ways that the forecast might be misinterpreted, and to incrementally improve the methods of communication.

Tapping Local Knowledge

Local knowledge is always changing. It is easy to assume that rural communities are culturally static, but to do so would be wrong. Population growth, urban migration, political activism, and increasing reliance on technology have all had a profound impact on the state of local knowledge. A community may have traditionally relied on natural climate indicators, but today only a few old people know how to interpret them, and people treat them with a fair amount of skepticism. Farmers facing new financial constraints are learning from scratch about what works and doesn't work for using retained seeds. None of these things are necessarily bad, but simply reflect the ubiquity of societal change. Workshop participants enjoyed learning about natural indicators from other cultures; they found it both interesting amusing that in Boston we measure the stripes on the wooly bear caterpillar to predict the snowfall for the coming winter. But just as few Zimbabweans know exactly how to interpret the fruit of the Mazhanje tree, so too do we suspect that few Bostonians today know how to interpret a wooly bear. Zimbabweans are sophisticated enough to understand that their local indicators likely have a solid basis in experience, and hence are valuable, but that they are far from foolproof. By respecting the value of local knowledge, understanding its limits, and appreciating farmers' sophistication, the forecast communicator can foster a more meaningful dialogue about the forecast information.

Conclusion: Looking for Value in Participatory Forecasts

By focusing on the first five constraints, one can design a communication process that lets the forecasts be as useful as possible. At the end of the day, however, one must ask how valuable the forecast actually are, and whether the sixth constraint proves binding. In light of the workshop experience over two years, the answer to this question not only remains uncertain, but also appears more complicated than first imagined.

The answer is uncertain for two reasons. First, we have not yet observed farmers using the forecast to make different decisions. After the first year of the workshops, farmers did not make any decisions differently from normal. In the second year, some farmers indicated that the forecast might influence their decisions, especially in light of the recent escalating cost of inputs. Continued work in these villages can examine whether the farmers attending the workshops did in fact use the information as they stated they might. Second, and more importantly, we have not yet communicated the type of forecast that is most likely to generate an observable response. This would occur in a year with either a very strong El Niño signal in either direction, and hence the greatest deviation from a prediction of climatology. Fortunately when this does occur, the workshops will have been going for several years, and farmers will be in the best position possible to use the information. We can then observe whether they actually put the information to use. That event may be years in the future.

Yet this study offers valuable interim lessons. Even a modest effort at good forecast communication, including appropriate downscaling, participation, and repetition, appears to have made them more understandable, trustworthy, and legitimate. Almost every participants expressed a hope that the workshops would continue in coming years. We suggest that these results are valuable in their own right, even if the forecasts do not directly lead to different farming decisions. More than anything else, the forecast workshops are a rare opportunity for subsistence farmers to learn about their world, and to feel like important members of it. In a strictly utilitarian society, this may not have value in its own right. But for real people, these effects add both pleasure and dignity, and hence value, to life. In the process of trying to help people, it is tempting to want to satisfy the most basic needs first, such as food, shelter, and clothing, and not to worry about the others until whatever current crisis has passed. However, if development in place such as Africa is going to become truly sustainable, it is because people enjoy the life it offers, and its process must seem less like crisis management. Forecasts, done right, not only build the human and social capital necessary for sustainable development, they make sustainable development fun.

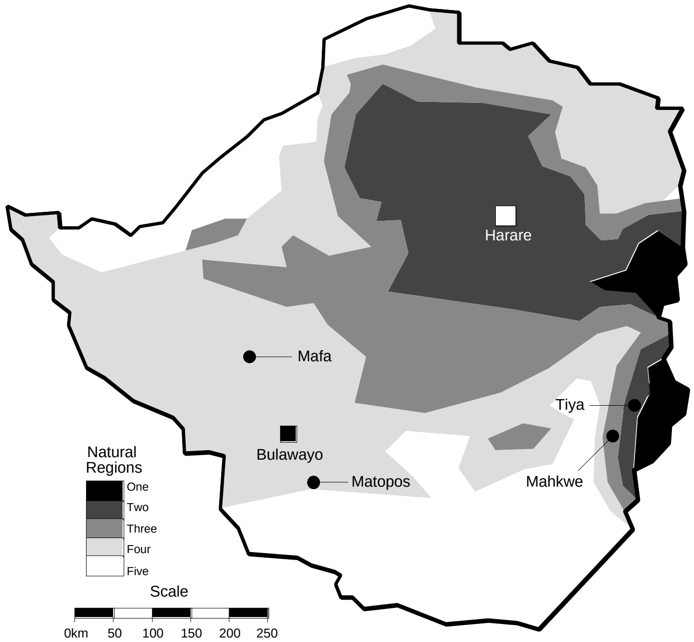

Figure 1—Zimbabwe's Natural Regions and Study Sites

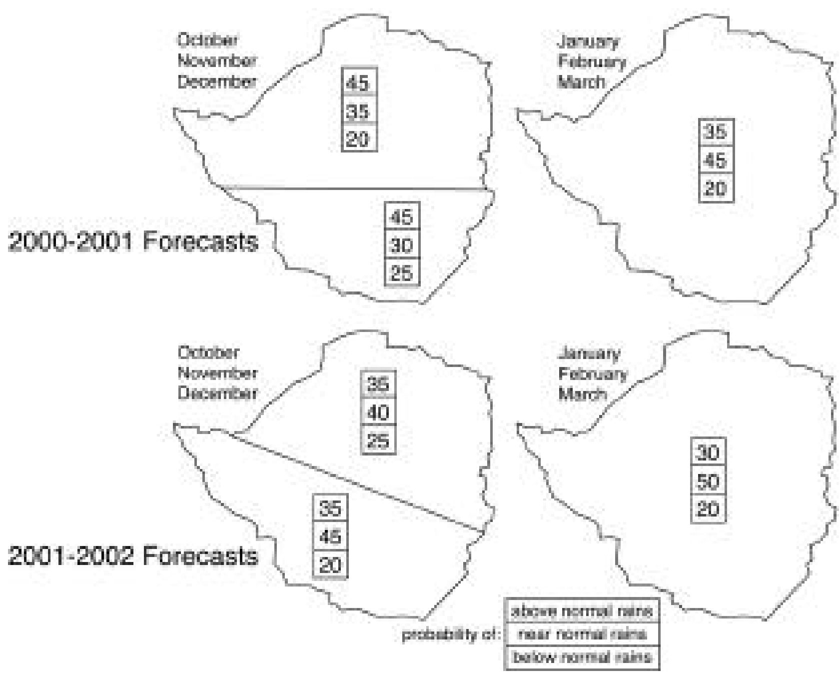

Figure 2—SARCOF Forecasts for Zimbabwe

Table 1—Developmental Stages in Risk Management

• All we have to do is get the numbers right.
• All we have to do is tell them the numbers.
• All we have to do is explain what we mean by the numbers.
• All we have to do is show them that they've accepted similar risks in the past.
• All we have to do is show them that it's a good deal of them.
• All we have to do is treat them nice.
• All we have to do is make them partners.
• All of the above.

Source: Fischhoff (1996, p. 81).

References

Alcamo, J., E. Kreileman, and R. Leemans (1996). Global models meet global policy: how can global and regional modelers connect with environmental policy makers? What has hindered them? What has helped? *Global Environmental Change* 6(4): 255-259.

Bourdillon, M. (1993). *Where are the ancestors? Changing culture in Zimbabwe*. Harare: University of Zimbabwe Press.

Breyer, S. (1993). *Breaking the vicious circle: Toward effective risk regulation*. Cambridge: Harvard University Press.

Broad, K. (1999) Climate and society: the case of the Peruvian fisheries. In T. Potter and B. Coleman (eds.). *Weather, Climate and Water: Handbook of Atmospheric Sciences, with Related Topics from Hydrology and Oceanography* McGraw-Hill.

Broad, K. and S. Agrawala (2000). The Ethiopia food crisis: uses and limits of climate forecasts. *Science* 289: 1693-1694.

Cane, M., Eshel, G., and R. Buckland (1994). Forecasting Zimbabwean maize yield using eastern equatorial Pacific sea surface temperature. *Nature* 370: 204-5.

Cash, D. (2000). Distributed assessment systems: an emerging paradigm of research, assessment and decision-making for environmental change. *Global Environmental Change* 10:241-244

Cash, D. and S. Moser (2000). Linking global and local scales: designing dynamic assessment and management processes. *Global Environmental Change* 10:109–120.

Covello, V. (1990). Risk comparisons and risk communication: issues and problems in comparing health and environmental risks, in Kasperson and Stallen (eds.) *Communicating Risks to the Public: International Perspectives*, Dordrecht, Kluwer Academic Publishers: 79-124.

Farrell, A. J. Jäger, and S. VanDeveer (forthcoming). The design of environmental assessment processes: global and regional cases.In A. Farrell and J. Jäger (eds.), *The design of environmental assessment processes*, publisher under negotiation.

Fischhoff, B. (1995). Risk perception and communication unplugged: twenty years of process. *Risk Analysis* 15: 137-45.

Fischhoff, B. (1996). Public values in risk research. *Annals of the American Academy of Political and Social Science* 545: 75-84.

Freudenburg, W. (1996). Risky thinking: irrational fears about risk and society. *Annals of the American Academy of Political and Social Science* 545: 44-53.

Glantz, M. (ed.) (2001). Once burned, twice shy? Lessons learned from the 1997-98 El Niño. Tokyo: United Nations University.

Glantz, M., M. Betsill, and K. Crandall (1997). Food security in southern Africa: assessing the use and value of ENSO information. National Center for Atmospheric Research, Boulder, Colorado.

Guston, D. (1999). Introducing Boundary Organizations. Paper presented at Workshop on Boundary Organizations in Environmental Science and Policy. December. New Brunswick, NJ.

Guston, D. (1998). Stabilizing the boundary between politics and science: the role of the Office of Technology Transfer as a boundary organization. *Social Studies of Science* 29(1): 87-112.

Jasanoff, S. (1990). *The fifth branch: science advisors as policymakers*. Cambridge: Harvard University Press.

Kahneman, D. & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica*, 47, 263-291.

Kammen, D., A. Shlyakter, and R. Wilson (1994). What is the risk of the impossible? *Journal of the Franklin Institute* 331A: 97-116.

Katz, R. and A. Murphy (1997). Forecast value: prototype decision-making models. In R. Katz and A. Murphy (eds.), *Economic value of weather and climate forecasts,* Cambridge: Cambridge University Press, pp. 183-218.

Leiss, W. (1996). Three phases in the evolution of risk communication practice. *Annals of the American Academy of Political and Social Science* 545: 85-94.

Nicholls, N. (1999). Cognitive illusions, heuristics, and climate prediction. *Bulletin of the American Meteorological Society* 80: 1385-97.

NOAA (1999). An experiment in the application of climate forecasts: NOAA-OGP activities related to the 1997-98 El Niño event, University Corporation for Atmospheric Research, Boulder, CO.

O’Brian, K., L. Sygna, L. Naess, R. Kingamkono, and B. Hochobeb (2000). Is information enough? User responses to seasonal climate forecasts in southern Africa. Report to the World Bank, AFTE1-ENVGC. Adaptation to Climate Change and Variability in Sub-Saharan Africa, Phase II. ISSN: 0804-4562.

Orlove, B., and J. Tosteson (1999). The application of seasonal to interannual climate forecasts based on El Niño - Southern Oscillation (ENSO) events: lessons from Australia, Brazil, Ethiopia, Peru, and Zimbabwe. Working Papers in Environmental Policy, Institute of International Studies, University of California, Berkeley.

Patt, A. (2000). Communicating Probabilistic Forecasts to Decision Makers: A Case Study of Zimbabwe. Belfer Center for Science and International Affairs (BCSIA) Discussion Paper 2000-19. Cambridge: Environment and Natural Resources Program, Kennedy School of Government, Harvard University.

Patt, A. (2001). Understanding uncertainty: forecasting seasonal climate for farmers in Zimbabwe. *Risk Decision and Policy* 6(2): 1-15.

Phillips, J., E. Makaudze, and L. Unganai (2001). Current and potential use of climate forecasts for resource-poor farmers in Zimbabwe. *Impacts of El Niño and Climate Variability on Agriculture*, American Society of Agronomy Special Publication Series 63: 87-100

Phillips, J. and B. McIntyre (2000). ENSO and interannual rainfall variability in Uganda: implications for agricultural management. *International Journal of Climatology* 20: 171-182.

Phillips, J., M. Cane, and C. Rosenzweig (1998). ENSO, seasonal rainfall patterns and simulated maize yield variability in Zimbabwe. *Agricultural and Forest Meteorology* 90: 39-50.

Scoones, I., C. Chibudu, S. Chikura, P. Jeranyama, D. Machaka, W. Machanja, B. Mavedzenge, B. Mombeshora, M. Mudhara, C. Mudziwo, F. Murimbarimba, and B. Zirereza (1996). *Hazards and opportunities: farming livelihoods in dryland Africa: lessons from Zimbabwe*. London: Zed Books, Ltd.

Shumba, O. (1999). Coping with drought: status of integrating contemporary and indigenous climate/drought forecasting in communal areas of Zimbabwe. Country Report prepared for the United Nations Development Programme / Office to Combat Desertification and Drought. Southern Alliance for Indigenous Resources, Harare.

Slovic, P. (1993). Perceived risk, trust, and democracy. *Risk Analysis* 13(6): 675-82.

Stack, J. (1998). Drought forecasts and warnings in Zimbabwe: actors, linkages and information flows. Department of Agricultural Economics and Extension Working Paper AEE 2/98, University of Zimbabwe, Harare.

Tversky, A. and D. Kahneman (1973). Availability: a heuristic for judging frequency and probability. *Cognitive Psychology* 5: 207-232.

Unganai, L. (1998). Seasonal climate forecasts for farm management in Zimbabwe. Proceedings of the Training Programme on Interpretation and Use of Seasonal Climate Forecasts for Agricultural Extension Workers in Zimbabwe, 18 November – 05 December 1998.

United States Environmental Protection Agency (1987). *Unfinished business*. Washington DC: U.S. Government Printing Office.

UNSO (1999). Report: workshop to enhance farmer use of climate forecasts. October 4 - 6, 1999, Kadoma, Zimbabwe. Prepared by the United Nations Development Programme and the United Nations Office to Combat Desertification and Drought.

Weber, E. (1997). Perception and expectation of climate change: precondition for economic and technological adaptation. In M. Bazerman, D. Messick, A. Tenbrunsel, and K. Wade-Benzoni (eds.), *Environment, ethics, and behavior: the psychology of environmental valuation and degradation*, pp. 314-341. San Franscisco: New Lexington Press.

Zeckhauser, R. and W. Viscusi (1990). Risk within reason. *Science* 248: 559-564.

Ziervogel, G. (2001). Global science, local problems: seasonal climate forecast use in a Basotho village, southern Africa. Paper prepared for presentation at the Open Meeting of the Human Dimensions of Global Environmental Change Research Community, Rio de Janeiro, October 6-8, 2001.

In a controlled study, farmers in Zimbabwe who reported adapting their farming methods to seasonal climate forecasts significantly improved their harvests over baseline amounts. Moreover, farmers who had attended a brief workshop and learned more about the forecasts were significantly more likely to use the forecasts than were farmers who learned of the forecasts through nonparticipatory channels. climate change. climate forecasting.